XXXIX.—*Observations on Raphides and other Crystals.*

By George Gulliver, F.R.S.

[Continued from p. 295.]

Crassulaceæ, Ficoideæ, and *Cactaceæ.*—In former examinations of a few of these plants, raphides were always found in Ficoideæ, and never in Crassulaceæ and Cactaceæ. Of these three orders parts (leaves when not otherwise noted) of different species have since been obtained, chiefly through the kindness of Mr. J. De Carle Sowerby, Mr. W. H. Baxter, and Mr. Cox, of which the examinations will now be given. *Crassula tetragona*: a few oblong-cubic or prismatic crystals in liber or alburnum of stem. *C.* (*perfossa*?) : a few short, abruptly truncated prisms. *Bryophyllum calycinum*: some sphæraphides and detached minute square crystals. *Monanthes polyphylla* (stem and leaf), *Sedum populifolium* (woody stem and leaf-buds), *S. dentatum, S. kamskatkicum* (root and leaf-buds), *Sempervivum rubricaule, S. arachnoideum, S. anomalum, S. hirtum, Echeveria secunda, E. pumila, E. papillosa, E. bracteosa, Pachyphytum bracteosum, Cotyledon*? *arborescens, C. umbilicus, Rochea falcata,* and *Tillæa muscosa*: no raphides, and other crystals very scanty. *Cereus hexagonus, C. flagelliformis, Rhipsalis paradoxa,* protuberances and spines of seven species of *Mammillaria,* four species of *Epiphyllum,* and two of *Opuntia* were also all devoid of raphides. But in *E. speciosum* were numerous coarse sphæraphides, a sort of crystalline grit, from which abruptly truncated prisms radiated; and *O. nigricans* and fruit of *O. vulgaris* were thickly studded with sphæraphides, about $\frac{1}{320}$th of an inch in diameter, especially in the outer part of the rind; while in its inner part and parenchyma the sphæraphides were less numerous, more irregular in size, and so much larger that their mean diameter was not less than $\frac{1}{100}$th of an inch. Of the fifteen species received of *Mesembryanthemum,* every one abounded in raphides, commonly in bundles; and many larger crystal prisms were seen in these plants: the raphis-cells were generally of a short oval form, by no means so elongated as in many other orders, and in the centre frequently appeared black from the accumulation of raphides. This was well seen in the leaves of *M. vaginatum, M. densum,* and *M. caninum,* and also in the parenchyma and pith of the stems of *M. barbatum, M.* (*tortuosum*?), and *M. perfoliatum.*

In Prof. Balfour's 'Manual of Botany,' these orders stand thus:—90, Crassulaceæ. 91, Ficoideæ. 92, Cactaceæ. And now all the above observations show raphides constantly present in the section Mesembryeæ of the central order, and as constantly absent in the two other orders. Still, that this remarkable

difference exists throughout the whole of these orders seems so unlikely, that nothing short of a complete examination of them would be sufficient to establish the truth of this question. Meanwhile it may be added that I have found this raphidian diagnosis never-failing, so far as regards three species of Mesembryeæ and ten of Crassulaceæ and Cactaceæ, being all the plants of these orders growing in my garden and in the windows of the neighbouring town. A satisfactory examination of the other sections of Ficoideæ would be very interesting. In dried fragments of *Tetragonia, Aizoon,* and *Sesuvium* I saw no raphides.

Rubiaceæ.—The following officinal articles were obtained, by the kindness of Mr. Ward, from the most authentic sources:—Root of *Cephaëlis Ipecacuanha*; five sorts of Cinchona-bark, to wit, Red, Yellow, Yellow Petago, Pale, Yellow Carthagena; berries of East-Indian, Plantation, and Mocha Coffee. After careful examinations, no raphides were found in any of these, except in the Ipecacuanha: this root contained a few raphides; and they were seen more plentifully in a fresh leaf of the plant, kindly sent by Mr. Moore, the excellent Curator of Chelsea Gardens. The officinal root was remarkable (especially its outer fleshy part) for an abundance of starch; in the central woody part were many long cells full of starch-granules, and it was chiefly made up of dotted ducts, like those of *Galium Mollugo*. Of the Cinchonæ, the pale was the only one consisting of all the layers of the bark, and it contained more starch than the others. Mr. Moore also favoured me with leaves of *Coffea arabica* and *Cinchona calisaya,* in neither of which could raphides be found; nor in a twig of *Cinchona micrantha,* kindly sent, with other contributions towards this inquiry, by Mr. Baxter.

In the British Flora, we have before shown that Rubiaceæ, consisting entirely of herbaceous species, stands as a raphis-bearing order closely surrounded by orders devoid of this function; while of eight exotic plants, of the section Cinchonaceæ, raphides abound in two herbaceous species, and could not be found at all in six woody ones, though sphæraphides in *Ixion* and *Gardenia* are numerous and beautiful. Subsequently, I have examined a few species, both native and foreign, belonging to the three orders standing, in Prof. Balfour's 'Manual,' on either side of Rubiaceæ, and failed to find raphides in any one of these plants, among which were fragments of six species of the order Loranthaceæ and two of Calyceraceæ, obligingly supplied, in compliance with my request, by the eminent botanist Dr. Hooker. Thus the presence of raphides in the herbaceous species and their absence from the woody ones further appear; and hence arises, in this wide and novel subject of the value of

raphides as natural characters, another of those interesting questions which can only be settled by further observations.

Musaceæ.—Bit of midrib and blade of leaf of *Musa textilis,* from Mr. Baxter: raphides scanty; but abundance of minute crystals, like those of *Citrus* ('Annals,' April last, p. 294), besides some hexagonal forms. *Heliconia aurantiaca* (leaf from Mr. Moore): petiole and blade with swarms of raphis-cells.

Iridaceæ and *Liliaceæ.*—Such fine examples of crystal prisms, about $\frac{1}{250}$th of an inch long and $\frac{1}{5320}$nd thick, are afforded by the officinal Orris-root (*Iris Florentina*), and of raphides, about $\frac{1}{270}$th of an inch long and $\frac{1}{1200}$th thick, by the officinal Squill, that the difference between these crystals may be examined at any time. There are also in the Squill numerous smaller raphides; and in the fresh bulb the raphides may be seen escaping from the rounded ends of the soft, ropy and mucus-like cells. I have before noticed the raphides in the leaves of *Ruscus.* Though always rather scanty, they are constant; and many bundles of them occur regularly in the perianth. The remarkable scarcity of raphides in our native shrubs and trees gives an interest to this little British shrub as a raphis-bearer. Raphides abound in the twigs and leaves of *R. Hypoglossum* from Mr. Sowerby.

Burmanniaceæ and *Hæmodoraceæ.*—Dried leaves, from Mr. Baxter, of *Burmannia,* sp., and *Anigozanthus,* sp.: raphides not found in the first, but abundantly in the last, and often in bundles.

Amaryllidaceæ.—A good example of the constancy of the raphis-bearing character is afforded by *Narcissus pseudo-Narcissus,* as I have found after many examinations, during different months and years, of wild plants in Derbyshire, Middlesex, Essex, Kent, Ireland and Scotland. Though the raphides are so abundant in its leaves, scape, and ovary-coat, they are not remarkable in the ovules. It is curious to observe the difference between the bulb-scales either of this plant or *Endymion nutans* and of some Allieæ and Colchicaceæ: bundles of raphides in the first two, short prisms in the third, and no crystals in the last.

Hypoxidaceæ.—Bundles of raphides numerous in a dried leaf of *Hypoxis,* sp., from Mr. Baxter.

Bromeliaceæ.—Leaf of *Bonapartea juncea*: a profusion of bundles of raphides, and of single, larger, four-sided prisms, flattened at the ends like a mason's chisel. Leaves, from Mr. Baxter, of *Ananassa sativa, Æchmea discolor, Dyckia rariflora, Tillandsia acaulis, T. zebrina,* and *T.* sp.: all abounding in raphides, which are also numerous in the stamens and perianth of an immature flower of this last species.

Pontederiaceæ.—Bit of dry leaf-stalk of *Pontederia azurea*

and of fresh leaf of *P. crassipes*, from Mr. Baxter: abundance of raphis-cells, and of crystal prisms, especially in the pith.

Xyridaceæ and *Juncaceæ*.—Bits of dried leaves of the three following, from Mr. Baxter:—*Xyris laxifolia* and *X. subulata*: no raphides. *Philydrum lanuginosum* (Xyridaceæ?): numerous acicular crystals lying singly along the leaf, the margin of which consists of prosenchyma, its transparent fusiform cells as long as in many sorts of woody pleurenchyma. Raphides were not seen in any of the few species examined of the British Juncaceæ.

Palmaceæ.—Cocoa-nut (*Cocos nucifera*), Palm-nut (*Elais guineensis*), Betel-nut (*Areca Catecu*), and Date-fruit (*Phœnix*), from shops: no raphides. Of the following, portions of leaves merely, when not otherwise noted, from Mr. Ward's fern-house, and from Mr. Moore, Mr. Sowerby, and Mr. Baxter:—*Rhapis flabelliformis, R. Sierotzik, Elais guineensis, Latania borbonica, Phœnix leonensis, P. dactylifera* (root, stalk, and leaf), *P. farinifera, P. sylvestris, P. humilis, Elate sylvestris, Seaforthia elegans, Chamærops*, two sp., *C. humilis* (bits of root and leaf), *Corypha australis, Areca alba* and *A. rubra*: raphides either not present or very scanty. *A. crenata, Thrinax parviflora, Chamædorea*, sp., and *C. Scheediana*: a few raphides. *Areca sapida, Sabal umbraculifera, Ceroxylon Andicola*, and *Caryota urens*: many bundles of raphides.

Pandanaceæ.—Leaves, from Mr. Moore and Mr. Sowerby, of *Pandanus utilis, P. spiralis*, and *Carludovica purpurata*: a profusion of raphides, the bundles of which are much shorter than their delicate translucent cells. Of this order, Prof. Balfour long since observed, "their spermoderm has numerous raphides."

Edenbridge, April 7, 1864.

[To be continued.]

XL.—*Histological Researches on the Formation, Development, and Structure of the Vegetable Cell.* By Prof. H. Karsten.

[Continued from p. 290.]

§ III. *On the Polarity of the Joint-cells of* Cladophora glomerata.

In an investigation of cell-development, *Cladophora glomerata* cannot be passed over, as its course of development furnished the foundation for the first theory of cell-formation, Mohl having employed it in his important and suggestive researches upon this subject—researches which have been repeated by all succeeding vegetable anatomists, who, almost without exception, have confirmed the results obtained by that highly esteemed observer.